Citation:

Sammel MD, Grisso JA, Freeman EW, Hollander L, Liu L, Liu S, Nelson DB, Battistini M. Weight gain among women in the late reproductive years. *Family Practice.* 2003; 20: 401-409.

PubMed ID: 12876110

Study Design:

Prospective Cohort Study

Class:

B - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

NEUTRAL: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

Evaluate correlates of weight gain in women ages 35 to 47 years.

Inclusion Criteria:

- Participant in Penn Study of Ovarian Aging
- African American or Caucasian
- 35 to 47 years old
- Reported menstrual cycles in normal range (22 to 35 days) for previous three months
- Have at least one intact ovary.

Exclusion Criteria:

- Any serious illness that might compromise ovarian or hormonal function (e.g., diabetes, liver disease, breast or endometrial cancer)
- Use of exogenous hormones or psychotropic drugs
- Alcohol or drug use within the past year
- Pregnancy, lactation or intent to become pregnant.

Description of Study Protocol:

Recruitment

Random digit dialing of women participating in the Penn Study of Ovarian Aging.

Design

Prospective cohort study.

Dietary Intake/Dietary Assessment Methodology

- Alcohol use: Self-reported typical weekly consumption over the past year
- Food: Food-frequency questionnaire (FFQ).

Intervention

Women were followed over a four-year period to evaluate correlates of weight gain.

Statistical Analysis

- Multivariate logistic regression models were used to estimate effects of covariates measured at baseline on subsequent weight gain; the model included all potential predictors with P-values less than 0.20 after adjustment for baseline body mass index (BMI) (categorized as less than 21, 21 to 24, 25 to 29 or 30 or more, with 21 to 24 kg/m^2 as reference)
- Interactions between risk factors of interest and BMI were evaluated to determine whether associations were modified by BMI. Interactions were considered further if the interaction P-value was less than 0.05.
- All psychological measures were associated with weight gain, but they were also significantly correlated with each other
    - Separate multivariate models were constructed examining each psychological measure
    - Measure of depressed mood, Center for Epidemiological Studies' Depression Scale (CES-D), was selected for the final multivariate model because it had greatest association with weight gain
- Developed final model using backward selection and included covariates based on whether the variable remained statistically significant at the $P \leq 0.05$ level and whether the inclusion of the variable modified other significant associations in the model by 15% or more.

Data Collection Summary:

Timing of Measurements

- Measures taken at baseline and subjects participated in six follow-up assessment periods at approximately eight month intervals over four years
- Within each assessment period, there were two visits one month apart to obtain blood samples for hormone measurements (average value used to minimize variability inherent in hormone values; baseline measures were averaged with first follow-up period)
- All visits were scheduled within the first six days of the menstrual cycle and included anthropometric measures, completion of standardized questionnaires and blood samples.

Dependent Variables

- Weight gain
- Waist to hip ratio (WHR).

Independent Variables

- Oestradiol (E2)
- Follicle-stimulating hormone (FSH)
- Leutinizing hormone (LH)
- Dehydroepiandrosterone sulfate (DHEAS)
- Testosterone
- Depression [Center for Epidemiological Studies' Depression Scale (CES-D)]

- Anxiety (Zung Anxiety Scale)
- Perceived stress [Cohen's Perceived Stress Scale (PSS)].

Control Variables

- Alcohol use
- Current and past cigarette use
- Diet
- Physical activity
- BMI.

Description of Actual Data Sample:

- *Initial N:*
  - 1,420 women
  - 402 refused further screening
  - 438 ineligible
  - 436 of 580 eligible participated
  - 353 completed the sixth interview approximately years after enrollment (of those, 17 did not provide blood samples for analysis)
- *Attrition (final N):* 336 women
- *Age:* 35 to 47 years
- *Ethnicity:* African American and Caucasian
- *Other relevant demographics:*
  - Majority (58%) of women were married
  - 90% had completed high school, some post-high school training or some college
  - Mean BMI (kg/m^2) was 29.3
    - 38% were normal or low weight (BMI <24)
    - 25% overweight (BMI 25 to 29)
    - 37% obese (BMI >30)
- *Anthropometrics:* 52% of African American women were obese compared with 25% of Caucasian women (P=0.001)
- Location: Pennsylvania.

Summary of Results:

Table 1: Comparison of Women Who Gained 10-lb or More with Women Who Did Not Over a Four-year Period

Variable	Weight Gain of 10-lb or More Yes	Weight Gain of 10-lb or More No	P-value[a]
Age N (percentage)			
35 to 39 years	34(29%)	82(71%)	0.039
40 to 44 years	39(26%)	110(74%)	
45 to 49 years	12(17%)	59(83%)	

Race N (percentage)			
Caucasian American	42(24%)	130(76%)	0.413
African American	43(26%)	121(74%)	
Education			
Less than high school	8(24%)	25(76%)	0.737
High school or more	77(25%)	226(75%)	
BMI N (Percentage)			
Less than 21	2(7%)	27(93%)	0.135[b]
21 to 24	30(31%)	68(69%)	
25 to 29	23(27%)	63(73%)	
30 or more	29(23%)	97(77%)	
Waist/hip ratio (average±SD)	0.81(±0.1)	0.81(±0.1)	0.763
Parity			
Average number of pregnancies±SD	3.4(±2.2)	3.0(±1.8)	0.085
QOL (average±SD)	48.4(±9.7)	50.7(±9.7)	0.041
Perceived Stress (average±SD)	21.4(±7.3)	21.0(±8.0)	0.373
Current Cigarette Smoker N (Percentage)			
Yes	30(24%)	93(76%)	0.986
No	55(26%)	157(74%)	
Alcohol (average drinks per week ±SD)	7.3(±15.2)	8.5(±19.0)	0.784
Fruit/Vegetables[c] (average servings per day±SD)	3.4(±3.3)	4.3(±3.7)	0.055
Breads/cereals[c] (average servings per day ±SD)	1.8(±1.9)	2.0(±1.7)	0.606
Dairy[c] (average servings per day ±SD)	2.7(±3.3)	2.8(±3.4)	0.898
Sweets[c] (average servings per day ±SD)	0.9(±0.9)	1.5(±2.3)	0.015
Protein[c] (average servings per day ±SD)	1.1(±0.7)	1.7(±2.6)	0.086
High fat foods[c] (average servings per day ±SD)	2.1(2.1)	2.2(±2.9)	0.739
Currently on a diet N (percentage)			
Yes	28(35%)	53(66%)	0.082

No	56(23%)	192(77%)	
Physical Activity			
Average number of blocks walked per day ±SD	10.5 (±16.8)	10.5(±24.7)	0.968
Average hours vigorous exercise per day ±SD	1.1(±1.4)	1.1(±1.3)	0.651
Average number of stairs climbed per day ±SD	9.5(8.6)	8.9(±7.5)	0.667

[a]Associations adjusted for BMI categories at baseline.
[b]Unadjusted test of association.
[c]Summary diet variables were created as follows:

- Fruit and vegetables: The sum of servings of fruits and juices, vegetables and green salads
- Breads and cereals: Sum of servings of bread, cereals and salty snacks
- Dairy: Sum of servings of milk, cream, yogurt, cheese and butter
- Sweets: Sum of servings of desserts and candy
- Protein: Sum of servings of red meat, fish, eggs and poultry
- High fat foods: Sum of servings of red meat, whole milk, cream, ice cream and butter.

Table 2: Multivariable Model of Predictors of Gaining 10-lb or More Among Women in the Late Reproductive Years

Variable	Odds Ratio	95% CI	P-value
BMI (kg/m^2)			
Less than 21	0.12	0.00 to 0.56	0.008
21 to 24	reference	reference	
25 to 20	0.90	0.44 to 1.82	
30 or more	0.62	0.32 to 1.23	
Age			
35 to 39 years	reference	reference	0.054
40 to 44 years	0.80	0.44 to 1.43	
45 to 49 years	0.39	0.18 to 0.87	
Race			
Caucasian American	reference	reference	
African American	1.11	0.61 to 2.00	0.741
Education			
Less than high school	reference	reference	0.632
High school or more	1.26	0.48 to 3.31	
Increasing parity	1.12	0.97 to 1.29	0.129
Increased sweets consumption	0.74	0.60 to 0.91	0.004

Other Findings

- Women gained a median of 2.4-lb over the four-year period
- Women whose weight gain was in the normal range at baseline were more likely to gain 10-lb or more (not statistically significant)
- No differences in proportion of African American and Caucasian American women who gained 10-lb or more, despite marked differences by race in BMI at baseline
- Cigarette smoking, alcohol consumption and most dietary factors did not affect the risk of substantial weight gain
- Women in the oldest age category (45 to 49 years) were less likely to gain substantial weight
- No self-reported physical activity measures were correlated with the risk of gaining 10-lb or more.

Multivariate Model

- No differences between the two groups in any hormone measures
- A CES-D score (related to Depression) of 16 or more was associated with nearly a two-fold risk of gaining 10-lb or more over the four-year period [odds ratio (OR) = 1.9, 95% CI: 1.09-3.31]
- All the psychosocial measures (depression, anxiety, perceived stress) were predictive of subsequent weight gain
- Increased consumption of fruit, vegetables and sweets was associated with decreased risk of gaining 10-lb or more; only sweets remained statistically significant in the final model ($P<0.001$)
- This study did not find a significant association between diet or exercise and weight gain among this sample of women. There was no association between high-fat foods, bread, cereal and salty snack consumption and weight gain. But the authors did find an inverse relationship between consumption of sweets and weight gain.

Author Conclusion:

- Major predictors of weight gain were psychological factors, including depressed mood, anxiety and quality of life. These factors were not correlated with weight at baseline and were predictive of weight gain in women with normal BMI and those who were overweight.
- Early prevention of weight gain may ultimately prove more effective than initiating weight loss.

Reviewer Comments:

- *The authors note the following limitations:*
  - *Using FFQs does not take into account portion sizes*
  - *Failure to detect a significant association of dietary factors and exercise with weight gain may be a problem of recall bias*
  - *At the four-year follow-up, 100 (23%) of women in the cohort were not included because of poor participation or insufficient hormone data, raising the question of non-participation bias*
  - *Many of the measures were self-reported*
  - *Diet instrument did not include complete information on carbohydrate consumption*
  - *Only African American and Caucasian American women were included; other racial*

groups were not represented nor were women from non-urban areas

- *Reviewer comments:*
  - *Inability to accurately assess portion size or validate dietary data is a significant confounding factor*
  - *Exclusion of 23% of sample due to "poor participation or insufficient hormone data" at the four-year follow-up is concerning, though the authors' analyses found no differences in weight gain or depressive scores (during participation) in those who continued vs. those who withdrew.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions		
1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions		
1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	???

3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	N/A
4.1.	Were follow-up methods described and the same for all groups?	???
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	???
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	???
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	No
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	???
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	???
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A

5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	N/A
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	No
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	No
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes

	8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
	8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	Yes
	8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
	8.6.	Was clinical significance as well as statistical significance reported?	Yes
	8.7.	If negative findings, was a power calculation reported to address type 2 error?	Yes
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**		Yes
	9.1.	Is there a discussion of findings?	Yes
	9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**		N/A
	10.1.	Were sources of funding and investigators' affiliations described?	Yes
	10.2.	Was the study free from apparent conflict of interest?	Yes